# Holaday HI-3002 Electromagnetic Broadband Exposure Meter

## Contents



## 1.0 Purpose/Scope

This procedure provides a standardized method for the operation of the Holaday Model HI-3002 Broadband Exposure Meter. It should be used in conjunction with the ESH Standard 2.3.2 Radio Frequency and Microwaves (RF/Microwave) and IH SOP IH-99150 *Radiofrequency and Microwave Measurement Principles: Area Surveys.* .

The Holaday HI 3002 is used to measure radiofrequency and microwave fields in the wavelengths of:
- 0.5 MHz to 6000 MHz (500kHz to 6 GHz) electric field, and
- 0.5 to 300 MHz (500 kHz to 300 MHz) magnetic field.

This meter can be used to:
- Determine the need for area warning posting,
- Determine if inclusion in a medical surveillance program is required,
- Measure the effectiveness of engineering controls,
- Locate problem rf/microwave sources and leaks,
- Determine the need for additional personal monitoring, and
- Delineate controlled areas.

## 2.0 Responsibilities

2.1 **Program Administration:** This procedure is administered through the SHSD Industrial Hygiene Group.

2.2 Members of the SHSD Industrial Hygiene Group are required to follow this procedure.

2.3 Other BNL organizations that provide BNL with field monitoring or other hazard assessment services are required to follow this SOP or an equivalent document that ensures an equal or superior method of assessment documentation and recordkeeping.

2.4 ***Industrial Hygiene Professional:*** The *Industrial Hygiene Professional* of SHSD and other BNL organizations are to be qualified by their supervision. These individuals will conduct or supervise industrial hygiene hazard assessments and personal exposure monitoring using this procedure. These *IH Professionals* are responsible for:

- Interpreting, reporting, and documenting personal exposure monitoring in accordance with the requirements of this procedure, other appropriate SOPs, and generally accepted professional standards and practices.
- Ensuring a quality report is prepared that documents the exposure, evaluates the relevance to exposure standards, and recommends protective and corrective actions.
- Ensuring the final report is provided in a timely manner to all appropriate parties.
- Ensuring that the appropriate data is correctly and completely entered into the BNL IH exposure monitoring database (i.e. *Compliance Suite*®).
- Ensuring that original records of sampling and analysis enter the SHSD *Record Custodian* filing system.

2.5 ***Industrial Hygiene Technician (Sampler)*:** The industrial hygiene technician is to be qualified by their supervision to conduct industrial hygiene personal exposure monitoring under the direction of his/her organization's *IH Professional.* The sampler is responsible for collecting personal exposure monitoring samples in accordance with the guidance of the *IH Professional* and the requirements of all SOP's pertinent to the particular monitoring requirements (i.e. Chain of custody, equipment check in/out, equipment operation, recordkeeping, etc.).

2.6 ***Compliance Suite® data entry:*** The management of the person conducting the sampling is responsible for entering complete and correct data into the BNL IH exposure monitoring database (i.e. *Compliance Suite*). This task may be assigned to one or more individuals who act as the data entry person for an organization, however, it remains the responsibility of the line management of the *Sampler* to ensure this task is fulfilled within 21 calendar days of the end of the sampling event.

## 3.0 Definitions See IH procedure 99150

## 4.0 Prerequisites

4.1 **Training prior to using this meter:**

4.1.1 Demonstration of proper operation of the instrument to the satisfaction of the employee's supervision.

4.1.2 Review of the *Non-Ionizing Radiation* SBMS Subject Area.

4.2 **Area Access**:

4.2.1 Contact the appropriate Facility Support Representative or FS Technician to obtain approval to enter radiological areas. Complete appropriate training for the area to be entered.

4.2.2 Verify with the appropriate Facility Support Representative or FS Technician if a Work Permit or Radiological Permit is needed or is in effect. If so, review and sign the permit.

4.2.3 Use appropriate PPE for area.

## 5.0 Precautions

**5.1 Hazard Determination:**

5.1.1 The operation of an area survey meter does not create exposure to any chemical, physical, or radiological hazards. The meters do not generate Hazardous Waste.

5.1.2 The meter design does not cause significant ergonomic concerns in routine use.

5.1.3 The meter is sensitive and can be burned by entry into fields above their capacity. Approach the source from a low background.

5.1.4 The primary hazard from rf/microwave is heating of the body. The eyes and genitals/reproductive organs are the most sensitive. Prolonged exposure to very high sources can result in death to the individual.

5.1.5 High standing waves – In high field areas with high standing waves or high reflections, high currents may be induced in the probe cable and handle. In

such areas, it may be advisable to use a resistive cable such as are provided in the Holaday Industries extension cables.

**5.2 Personal Protective Equipment:**

5.2.1 If high fields are expected, the NARDA Alert alarming meter can be used to alarm in high fields.

5.2.2 Rf /microwave protective clothing is not available. Rely on engineering and administrative controls such as remaining a safe distance from the source as indicated by this direct reading meter.

5.2.3 Additional PPE: Other appropriate PPE for hands, feet, skin, head, or eyes may be needed for the area being entered. Check with the area FS Representative.

5.3 **Job Risk Assessment:** Consult the *Job Risk Assessment* below for the hazards and controls of this SOP.

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Frequency | ≤once/year | ≤once/month | ≤once/week | ≤once/shift | >once/shift |
| Severity | First Aid Only | Medical Treatment | Lost Time | Partial Disability | Death or Permanent Disability |
| Likelihood | Very Unlikely | Unlikely | Possible | Probable | Multiple |

| Activity | Hazard | Control(s) | Before Additional Controls | | | | | | Control(s) Added to Reduce Risk | After Additional Controls | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Stressor | # of People A | Frequency B | Severity C | Likelihood D | Risk* AxBxCxD | | Stressors | # of People A | Frequency B | Severity C | Likelihood D | Risk* AxBxCxD | % Risk Reduction |
| Taking NIR measurements with direct reading meters | Exposure to IR E and H fields | Observation of meter reading and maintaining appropriate distance from hazardous levels. | N | 1 | 2 | 1 | 3 | 6 | | | | | | | | |
| | Exposure to other hazards such as chemicals and ionizing radiation | Follow Work Control Procedures and Radiological Work Permits in the area | N | 1 | 2 | 2 | 2 | 8 | | | | | | | | |

**5.4 Interferences**

5.4.1 It is important that you know the frequencies of concern. The meter may read falsely high.

5.4.2 If there are interferences, such as a CRT in the 15-100 KHz range, that may induce voltages into the detection system via feed lines rather than antennas, and hence it is impossible to correlate the reading of the instrument with a meaningful calibration. The same may be said about the case where measurements are attempted in the presence of high 60Hz fields such as would be found under very high voltage transmission lines.

5.4.3 When pulses are very short and repetitive (1-2 seconds), such as at the LINAC, this is not the instrument will display pulse in the reading that cannot be quantified.

## 6.0 Procedure

6.1 Follow the decision logic and monitoring strategy outlined on IH 99150.

- Determine the duration of the pulse and the number of repetitions per time (sec; min, etc.) of the source.
- Determine if the range of the source is within the range of the equipment:
  - Electric probe STE - range 0.5 MHz to 6000 MHz (500kHz to 6 GHz)
  - (Magnetic probe CH– range 0.5 to 300 MHz (500 kHz to 300 MHz)
  - (Magnetic probe LFH– range 0.5 to 10 MHz magnetic.

Follow the decision logic in the flow chart in IH99150.

- Start with the E field measurement.
- If the frequency is less than 300 MHz, an H field measurement is required.
- If the frequency is less than 100 MHz and the time and spatially averaged E field (measured as a percentage of the TLV) is greater than the ACGIH (BNL) OEL, then make induced or contact current measurements using the Holaday HI–3702 Clamp on Induced Current Meter; HI4416 System readout.

6.2 **Calibration:** Determine if the probes are in calibration, as per SOP IH51660. The meter can only be factory calibrated.

6.3 **Check the battery:** The "Battery" indicator LED will blink when the unit is turned on and the batteries are good. When the battery voltage drops below a safe operating level, the LED will light steadily and will not blink. The battery pack will provide approximately 30 hours of continuous use or up to 40 hours of intermittent use.

**6.4 Operating instructions**

6.4.1 Insert a probe into the handle and, with light pressure, rotate the probe until the alignment marks meet and the keyway is felt; then fully seat the probe in the handle connector. Secure the probe in the handle by tightening the locking collar.

6.4.2 Turn the selector switch to the desired range. The probes are color-coded and correspond to the colored scale multipliers selected by the range selector switch on the front panel.

6.4.3 Zeroing: There is no zero adjust since the unit has automatic, full-time self zeroing capability Move the PEAK HOLD switch to the left to clear the memory.

6.4.4 Peak Hold: The memory is active any time the instrument is on. It is continually being updated with the highest reading observed since the last switch operation. Activating the PEAK HOLD switch indicates the highest reading, then releasing the switch automatically clears and zeros the memory. Since a time-averaged signal is important in making safety measurements, the actual meter indication or recorder output will usually provide a more suitable reading.

6.4.5 The "OVER RANGE" LED will light if the following conditions occur if the integrated signal is greater than full scale. In the event of any over range condition switch to the next higher range. The meter will automatically re-zero.

6.4.6 Audible Alarm: The unit can support a headset through which the operator can hear an audible "Geiger" type clicking and alarm whenever an over range condition occurs.

**6.5 Taking Measurements**

6.5.1 **Operator Position:** Preferably the operator should be further from the source than the probe. Hold the probe at arms length, not close to the body. Approach source, taking reading from a low background. Make sure the probe does not get overloaded. Overloading will result in burning out the probe.

6.5.2 Keep the probe away from reflective surfaces.

6.5.3 **Low Frequency Measurements:** When measuring electric fields, at frequencies below approximately 3MHz.: minimize unwanted pickup by placing the probe handle perpendicular to the field orientation and carefully coiling the probe cord. Keep the probe away from the body or any object that could cause reflections or radiation to be picked up by the probe. The meter can be placed on a non-conducting support, such as a

wooden stepladder or stand. Back away from the instrument until the reading stabilizes. The meter scale is easily read from several feet away.

6.5.4 Spatially averaged levels are needed when:

- Specified in an Occupational Exposure Limits (OEL). For compliance with the ACGIH (BNL) standard – the average of a series or ten field strength measurements is performed in a vertical line with uniform spacing starting at ground level up to a height of 2 m (~6 feet 8 inches) separated by 20 cm (about 8 inches).
- In exposure situations where the distribution of field strengths is substantially nonuniform over the body, for frequencies less than 300 MHz. Determine the spatial average of the exposure fields over the plane occupied by the body.
- When nonuniform fields are encountered in reflective conditions such as standing wave fields produced by reflection of fields from the earth or other reflective surfaces.

6.5.5 Take measurements at the employee's level (whether sitting, standing or bending) to estimate personal exposures and to locate isometric lines of RF field intensity on a sketch for defining area levels.

6.5.6 Measurements should be taken at least 8 inches away from the surface of the source.

**6.6 Units of Measure**

6.6.1 The instrument displays in $|FSU|^2$ which means field strength units squared. When using an E- field probe, the units are $V^2/m^2$ and when using an H-field probe, the units are in $A^2/m^2$.

In the near-field region, both the E and H field strength vary greatly with small changes in distance. Each must be measured independently.

*6.7* **Recording readings:**

6.7.1 Plan and conduct hazard assessments and exposure monitoring using the procedure outlined in I*H 60500 Reporting Personnel Exposure Monitoring Results* for:

- Exposure Assessment Sampling Strategy,
- Initial Notification of Employee Monitoring Results, and
- Preparation of a formal report on the exposure monitoring or hazard assessment.

6.7.2 Use a Direct Reading Sampling Instrument Form o*r equivalent* to record readings and additional required information.

6.7.3 Return meter and original sampling form to the SHSD IH Laboratory.

6.7.4 Ensure that a copy of any hazard evaluation report written by a competent person on the survey is sent to the IH Laboratory and the Occupational Medicine Clinic, the department ESH coordinator, and the individuals surveyed.

**6.8 Calculations**

6.8.1 If the spatially averaged mode is not used, average the values across the vertical range (take the square root of the average of the squares of the values of the vertical range) or visually identify the highest value as the worst-case incident.

6.8.2 If values are greater than or equal to 50% of the standard, then individuals are referred to the occupational medicine clinic for inclusion in the RF protocol. Further review should be made to determine what additional controls or procedures should be instituted.

## 7.0 Implementation and Training

Prior to using this procedure, the user:

7.1 Demonstrates proper operation of this instrument to the satisfaction of line supervision or SHSD IH Program Administrator.

7.2 Completes other appropriate training for the area to be entered (check with ESH coordinator or FS representative for the facility).

7.3 Completes OT&Q Training and a medical surveillance required for any PPE used on the job or for other hazards encountered in the work area.

7.4 Completes qualification on this procedure on at least a 3 year basis, providing the professional uses the equipment several times per year.

7.5 Personnel are to document their training using the Qualification Criteria listed in *IH51800 Industrial Hygiene Service Delivery Basic Qualification Requirements.*

## 8.0 References

8.1 ACGIH Documentation of TLVs. American Conference of Governmental Industrial Hygienists.

8.2 *Non-Ionizing Radiation* SBMS Subject Area.

8.3 Holaday Industries, Inc. HI-3000 series Broadband Isotropic Field Strength Meter Owner's Manual. Copyright 1991.

## 9.0 Attachments

9.1 Photo of parts
9.2 Probe Specifications

## 10.0 Documentation

| Document Review Tracking Sheet | | |
|---|---|---|
| **PREPARED BY:**<br>*(Signature and date on file)*<br>**N. M. Bernholc**<br>**SHSD IH Group**<br>**Date 01/22/02** | **REVIEWED BY:**<br>*(Signature and date on file)*<br>**J. Peters**<br>**SHSD IH Group**<br>**Date 02/05/02** | **APPROVED BY:**<br>*(Signature and date on file)*<br>**R. Selvey**<br>**SHSD IH Group Leader**<br>**Date 02/11/02** |
| **Filing Code:**<br><br>**IH51QR.02** | **DQAR**<br><br>**Date** | **Effective Date:**<br><br>**02/11/02** |

| Periodic Review Record | | |
|---|---|---|
| Date of Review | Reviewer Signature and Date | Comments Attached |
| 03/29/05 | *(Signature and date on file)*<br>R. Selvey 03/29/05 | Revised to include Section 7 Implementation and Training. Text added to Section 2, 4,5, 6, and 7. JRA added to Section 5. |
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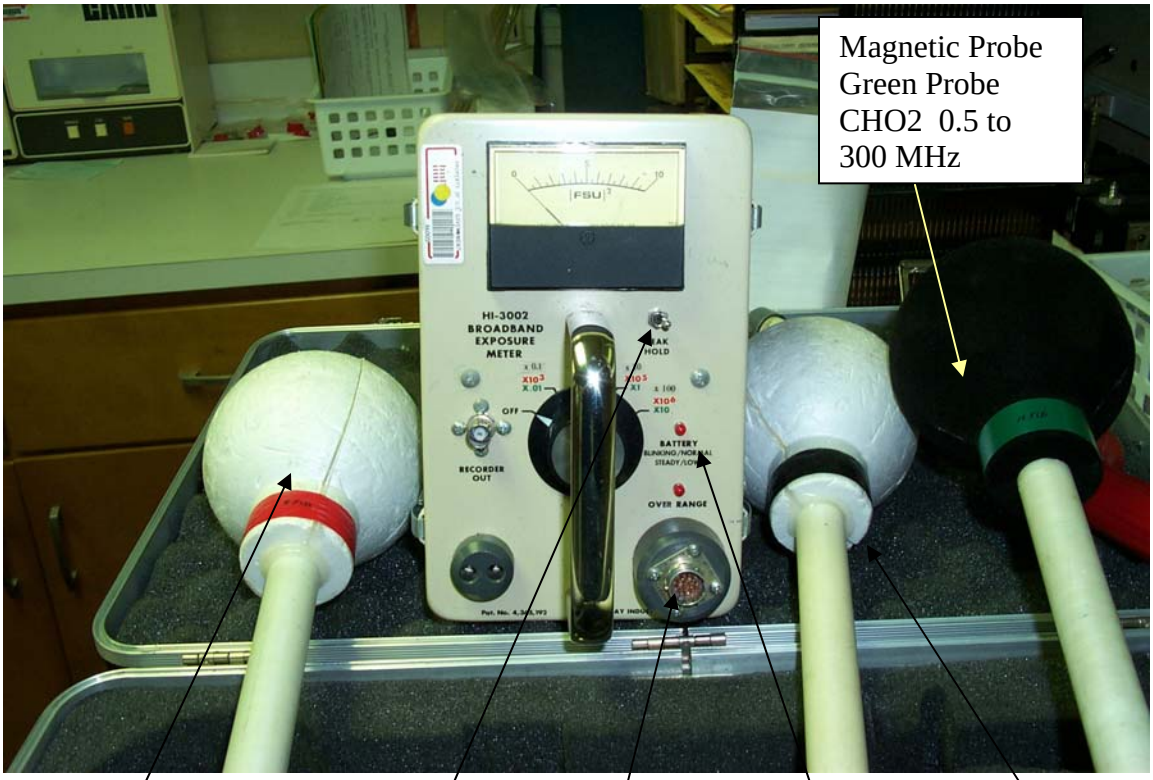
# Attachment 9.1a
# Photo of the Meter




Red Electric Probe STEO 0.5 MHz to 6000 MHz

Peak Hold Switch

Connection for probes

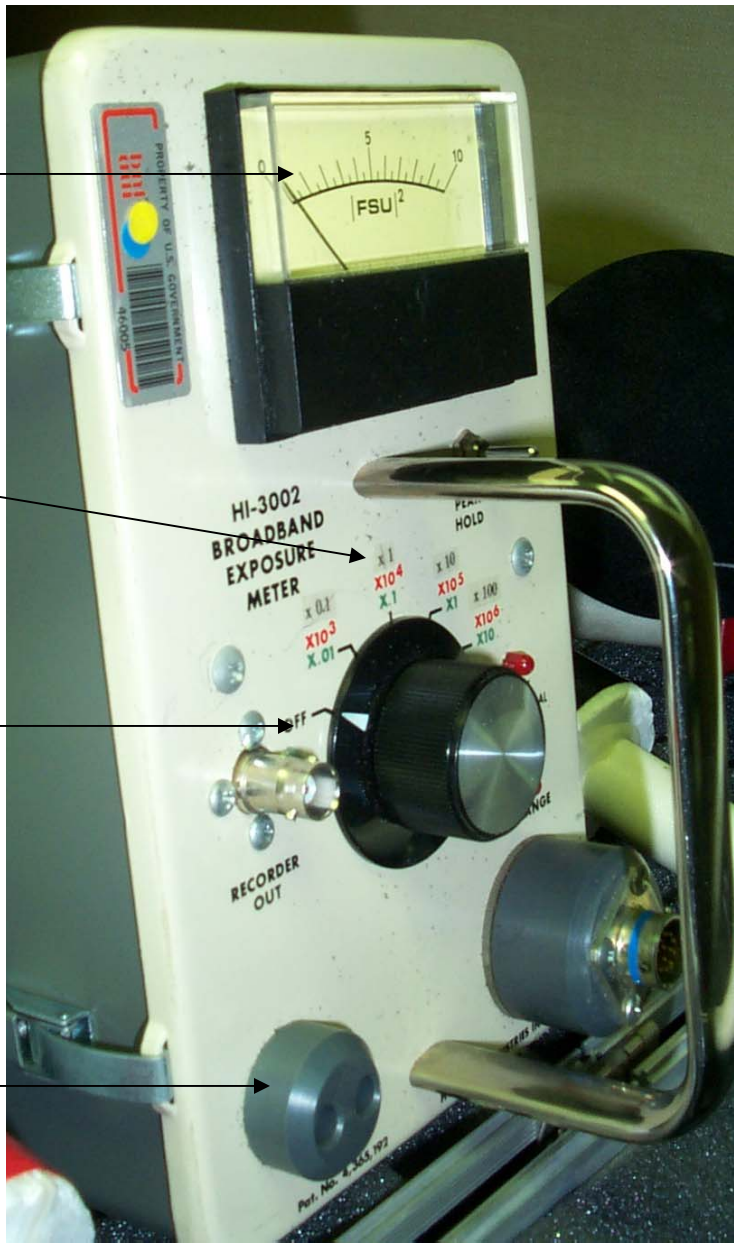
Over range & Battery Indicator lights

Low Magnetic Probe Black Probe LFHO - 0.5 to 10 MHz magnetic.

| BROOKHAVEN NATIONAL LABORATORY<br>Safety & Health Services Division<br><br>INDUSTRIAL HYGIENE GROUP<br>Standard Operating Procedure: Field Procedure | NUMBER<br>IH99280<br><br>REVISION<br>FINAL rev1 |
|---|---|
| SUBJECT: GENERAL PRINCIPLES:<br>Holaday HI-3002 Electromagnetic Broadband Exposure Meter | DATE<br>03/29/05<br><br>PAGE<br>11 OF 12 |

# Attachment 9.1b

Photo of the Meter



# Attachment 9.2
# Probe Specifications

| | Probe Range MHz | Scale | Reading range \|FSU\| | Equivalent maximum Power Density ($mW/cm^2$) |
|---|---|---|---|---|
| **STE Red** | 5 – 6000 | | ($v^2/m^2$) | |
| | | 1 | $10^4$ | 2.65 |
| Electric Field Probe | | 2 | $10^5$ | 26.5 |
| | | 3 | $10^6$ | 265 |
| | | 4 | $10^7$ | 2653 |
| **CH Green** | 5 – 300 | | ($a^2/m^2$) | |
| | | 1 | 0.1 | 3.77 |
| Magnetic Field Probe | | 2 | 1 | 37.7 |
| | | 3 | 10 | 377 |
| | | 4 | 100 | 3770 |
| **LFH Black** | .3 to 10 | | ($a^2/m^2$) | |
| | | 1 | 1 | 37.7 |
| Magnetic Field Probe | | 2 | 10 | 377 |
| | | 3 | 100 | 3770 |
| | | 4 | 1000 | 37700 |